In what case is it possible to speak about Mathematical capability among pre-school children?

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Abstract:
Most of people have fatal attitude to Mathematics: some of them are capable to learn it form nature, but the others are not. So is their fate – to suffer from it for the whole of life… But it is a rude though natural mistake, as it results from means of mathematical education and its content. Most of parents and teachers are directed on these aspects both in kindergarten and at primary school. Of course, parents are different. Nevertheless so many parents can't possibly but speak about achievements of their children. Some start making their own children learn better by the example of success of the others. They make their children learn long chains of figures with no understanding. It is even more sad to see how a mom asks her 4-year old son: "How much is two plus three?..' But he replies just because he learned the answer but not calculated.
Not only parents but also kindergarten tutors don't want to understand that drilling for arithmetic has no sense. For a specialist it would take two days only…But teach him how to think logically – is a goal demanding from him, reached by different means.

Introduction

About Mathematical Abilities

It is clear, that capability to any subject or other activity are determined by individual psycho features, genetic predisposition. Although nowadays there is no evidence to stipulation of abilities by neural tissues of any kind. Moreover, it is possible to compensate even unfavorable abilities. Task-oriented approach will lead to personal growth, formation of clear-cut abilities, which is proved by certain experience.

Mathematical abilities are from a group of so called *special abilities* (e.g. musical, painting etc.). To reveal their existence certain knowledge is needed, together with certain skills, namely skill to use knowledge in mental activity.

Mental activity – the key type of mathematical activity. Realization of its results is one of the strongest stimulations for current development of the civilization.

The problem of knowledge digestion and accumulation is traditionally connected with natural figures' apprehension and operations with them: counting, adding on, arithmetic operations and comparing, changing the scalar quantities, as well as quantities with nonnegative results of change.

Many educational programs create the mathematical content with the focus on "natural numbers and operations with it". The process of mathematical … formation is aimed at content (knowledge) and operational (skills) elements of curriculum. In other words, "certain knowledge base" is associated with knowing the natural numbers, whereas "collection of certain skills" can be understood as practical operations with numbers – counting, adding on and use of symbols (operational figures and signs), typical mathematical problem solutions etc.

Both Russian and foreign researchers associate formation and development of mathematical abilities among school children with mental processes (not with subject knowledge and skills).

Talented children usually have number of specific characteristics, namely, flexibility of mind, i.e. fresh thinking and ability to various cognitive problem solving, easy transfer from one problem to another, ability to come out of usual activity and find new solutions under changing conditions. Such peculiarities of mind are directly depending on specific memory organization as well as on imagination and perception.

Researchers point out also such characteristics as *deepness of thinking*. By this they mean ability to penetrate into essence of each fact and event, observe their interconnections with other facts and events, uncover specific, implicit characteristics of the learned material.

Among major characteristics in mathematical thinking there is *task-oriented thinking* in combination with its *breadth,* i.e. ability to formulate general ways of thinking, skills of team vision of a problem. Prior to all other categories mentioned above, specific or natural aptitude to structural approach to a problem and maximum stability, concentration and amount of attention.

Mathematical abilities are closely connected with cognitive abilities, including *sensitive* (perception and observation of subjects and events) and *intellectual abilities* (out-coming information processing). Consequently, task-oriented development of all mental characteristics as well as sensitive and intellectual abilities (thinking as operational process, i.e. independent analysis making, synthesis,

comparison and other mental operations) on the mathematical material will favor general development of mathematical abilities among children.

Why do some challenges appear?

Special or subject knowledge allow us "speak the language of Science" – operate with sign systems? Peculiar to a particular system, reveal and describe logics of conclusions with the help of familiar symbols (in our case – figures, letters, signs). Knowledge recorded in such a way becomes clear to an onlooker (a teacher, a tutor, parents), seeing and estimating cognitive results. Although the most important part of a mathematical process is left outside.

Initial mathematical visions of a child are formed on work with numbers and operations with them (i.e. counting and arithmetic operations). Great variety of symbols allows to make the process "transparent" and controlled. On the other hand, such process can not serve development neither of mathematical thinking nor mathematical abilities.

The main way of pre-school children development is empiric generalization, i.e. generalization of their sense experience. Accumulation of such experience is based on sensory capabilities of a child (vision, hearing, sense of touch) and its "processing" is realized through intellectual capabilities. It is necessary to provide a child with conditions for investigation and experimenting, in order to start the "engine" of this process. In other words, educational content should be both acceptable by senses and favor his experimental needs. Such experimenting may result in development of a child on the way of the World perception and understanding.

You, probably, have mentioned that there is a kind of contradiction: a figure as a mathematical issue is a highly general abstraction with … from basis of its construction. Despite of the way chosen for "natural number's" construction – on the meaning of "set" or on scalar quantities' measurement – Number as the key issue of mathematics is abstract, impossible to be directly perceptible for senses. Any "object snap" of a Number (e.g. use of trees, rabbits for counting) is a double loss of abstraction and consequently loss of the essence's generality. We should speak about "double" loss because in this case we deal not with graphic image (number of pixels) but variety of trees or rabbits, etc. This image is directly percepted by a child, acts in experiments. Results are fixed in empiric generalization. This can e proved by the fact that primary school children often loose results of such generalization when the teacher change rabbits for trees, for example. They see this change as a new situation and repeat the whole process from the very beginning.

Theoretically we may conclude about importance of numerous experiments with different objects for the sake of right empiric generalization. But in practice it is not true for many cases. Reasons are different and vary from individual perception abilities up to lack of descriptive materials. In this sense, traditional substitution of independent work with observation of the teacher's activity can not be adequate. So, contradictions mentioned contain reasons for high level of unpredictability, if we speak about creation of mathematical abilities.

Early introduction into numeric and sign symbols (i.e. early symbolization) is not widely recognized. Pre-school children learn it very easy as it is usual way of coding for their plays. Nevertheless, symbols get separate meaning due to absence of ready symbols configuration. Herewith its external manipulation replaces implicit operating with mathematical notions and relations.

There is a great variety of examples from teaching practice. They prove independence of symbols if we speak about the children's mind. At the same time, its link with real sense of notions and relations is quite peculiar. Judging from experience and examples given above it is evident to say that children can easy remember order of presentation as well as symbols themselves. On the one hand, examples show lack of flexibility and deepness of child's thinking; on the other hand, they reveal tendency to formalization (it is easier to learn strictly shaped images).

Arithmetic? Algebra?? Geometry!!!

There are several components in the mathematical content: arithmetic material, algebraic and geometrical materials. The first and the second ones are incorporated into quantitative characteristics of subjects and their groups (arithmetic is based on notion "number"), are connected with generalization process of their qualitative characteristics (letters are used in algebra for qualitative characteristics) and operations (algebra is based on notion "operation" equal to more general notion "actions" from arithmetic).

Even slight analysis of mathematical notions mentioned above proves that we deal with abstractions of high-level difficulty and generality. In particular, counting of apples in a set or rabbits on a meadow need a child to be disembodied from all perceived objects' qualities (color, size, shape, taste etc.). At the same time a child should concentrate on such characteristics as "quantities of variety ". As for

algebraic symbols, it needs disembodiment not only from qualities and characteristics of objects but also from their quantity: x of rabbits, y of carrots.

Learning of Geometry has its specific character, too. Its major components are figures and bodies on two- and three-dimensional space. As it is possible to create models of all geometric objects, investigate and operate with them, initially and in pre-school period we usually use sensor abilities of children.

Analysis of mathematical programs and manuals for school children reveal an interesting tendency: mathematical educative material mainly consists of arithmetical material. Among typical exercises for 1st-year pupils there are counting, numbers and natural numbers' qualities accompanied with arithmetical exercises, addition and subtraction tables, arithmetical problems, multiplying and division tasks, double figures etc.

It is a kind of paradox because all notions mentioned are highly abstract and demand not on "imagination" but abilities of abstraction without sensory support, which turn to be impossible for a 5-6 years old child.

Use of geometrical content in work with pre-school children helps to omit all these methodological challenges. A model of any geometrical notion can be directly perceived by a child. Besides there are other advantages of geometrical material use:

It helps in work with the "Zone of proximal development" with reference to experience and knowledge of children. More difficult task motivates a child for new activities in mathematics. First, children copy models and way of work with them assisted by a teacher; then try to construct according to a picture etc.

2. It helps in creation of evolutive environment with the help of new material use (but not by speeding educational process).

For example, a 2-3 year child makes easy compositions operating with geometrical figures. In fact, he learns their features and qualities (sides' length, parts positions etc.) In 3-4 years age a child analyses their similarity and differences in their size, sides' length, their number etc. When a child is 6-7 years old, he compares different objects, formulates comparison's and generalization's results, makes an assessment of qualitative characteristics, describes separate space and qualitative aspects of the objects etc.

In this case, we don't need annually insert new figures, enlarge list of notions, borrow new issues from school program. The only thing needed is set of new exercises, reveal of new features in familiar notions and new relations between them

3. Geometrical material helps in resting on children's interest in experiments – natural means for learning the material by children of a certain age.

4. It stimulates the process of mental development, necessary for any cognitive problems solution.

5. It gives an opportunity for building the educational process based on plays. They are interesting for children as constructive activity itself is perceived by children as a play, makes them interesting and does not acquire additional plots.

6. It promotes graduate and more stable learning the material. Initially, on the stage of an adequate mental act's formation an external base is needed. It will be used by a child as a model later on. Working with arithmetical material we may face some problems with such external basis' creation.

7. By means of mathematical activity it helps in development of such qualities of a child as observancy, assiduity and ability to plan succession of operations etc. So, structures of any kind need child's ability to work with notions and relations.

Effective development of mathematical way of thinking on the geometry material is connected with formation and development of cognitive abilities (both sensory and intellectual). In this context, education is based not on qualitative but space objects' characteristics. It means that first forms and motions are perceived, and then come qualities. It makes all children equal in ability to learn mathematics. Consequently, we may state that reasons for "mathematical abilities" being a rare case lie in educational system as such. System of introduction into the world o mathematics does not coincide with children's way of understanding it.

It is well known that not all abilities of children are seen on the surface, so a teacher needs to find, reveal them. Unfortunately, this pedagogical axiom does not work if we speak about methods of teaching mathematics. Teaching the subject is aimed at content but diminishes the key objective of any kind of education – personal development of a pupils resulting in abilities creation, mathematical abilities including.